

deoxidising agent. It possesses greater affinity for oxygen and also for sulphur than iron does, and it eliminates the two harmful substances named, or paralyses their action. It possesses, however, in addition the desirable property of increasing to a certain degree the tenacity of the metal and of giving it the capability at high temperature to preserve cohesion; and also, if it is strongly exposed to strains which are not to be avoided in mechanical working.

On these grounds, a manganese addition, which takes up the excess of oxygen, is made at the end of the "heat." The reaction occurs without evolution of gas, and the resultant manganese protoxide does not markedly impair the quality of the metal if it should not be allowed time to separate, and it therefore remains suspended in the metal.

But the action of manganese also is not complete. An excess must, therefore, be employed, and this excess increases the manganese content of the metal. Therefore, the degree of the completeness of the deoxidation depends on the manganese addition, and as to this, H. H. Campbell, speaking of the acid open-hearth furnace process, says (p. 188) :

"... If 1.00 per cent, of Mn be added, there will be .60 per cent, in the metal, being a loss of 40 per cent., while if .50 per cent, be added, the steel will have .40 per cent, being a loss of only 20 per cent. It seems as if with the lower manganese the action was not perfect, and that with each successive increment of ferro an additional atom of oxygen is removed. This fact holds good whether the recarburiser is added in the furnace or the ladle."

The same is valid for the basic open-hearth furnace.

Manganese is always employed in the form of an alloy with iron, and indeed mostly as highest possible percentage ferro-manganese, which always contains carbon. This, however, likewise takes place in the reaction, whilst carbon-monoxide is formed anew, and therefore deoxidation by means of ferro-manganese gives rise to a renewal of gas formation, which is the greater the more oxygen has been taken up by the metal, and under some circumstances allows it to assume a quite considerable extent.

If one taps out a highly oxygenated metal immediately after